Aerospace NESHAP Compliance through Pollution Prevention-
TRIAD Implementation

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INTRODUCTION

Robins Air Force Base (AFB), home to Warner Robins Air Logistics Center (WR-ALC), is the single largest industrial complex in the state of Georgia. WR-ALC performs heavy repair and maintenance on C-130, C-141, and C-5 transport aircraft, the F-15 fighter, and avionics, electronic warfare, and aerospace ground equipment (AGE). Robins AFB also hosts the 116th Bomb Wing (B-1B), the 93rd Air Control Wing (J-STARS), and the 19th Air Refueling Group (KC-135R). Multiple aircraft-related activities occur all over the installation, and many of these activities require materials and processes regulated by the National Emissions Standard for Hazardous Air Pollutants (NESHAP) for Aerospace Maintenance Facilities. This regulation goes into effect on 1 September 1998, and any operations not in compliance will be halted. Robins AFB has identified three main process areas currently non-compliant with the Aerospace NESHAP: 1) Handwipe Cleaning; 2) Spray Gun Cleaning; and 3) Depaint of F-15 wings and stabilizers.

Clearly, Robins AFB is in immediate need of finding replacement materials and/or processes to bring them in compliance with the Aerospace NESHAP. In addition to regulatory compliance, alternatives must satisfy the requirements of the environmental, safety, and occupational health (ESOH) community and the systems engineers. Successfully attacking each non-compliant process requires a flexible methodology to devise a project budget, a unique development and test plan, and a feasible implementation plan. Robins AFB's needs are being met through the Toxic Release Inventory Alternative Development (TRIAD) project, a total engineering, environmental, safety, and occupational health (E-ESOH) management approach and partnership among systems engineers, the ESOH community, and SAIC.

OBJECTIVES

With regard to the Aerospace NESHAP, the objective of Project TRIAD is to identify and validate NESHAP compliant materials or processes to ensure no mission-critical operations are halted due to non-compliance. Operations currently out of compliance with the Aerospace NESHAP utilize materials such as methyl ethyl ketone (MEK), denatured alcohol, and some paint thinners. It is the goal of Project TRIAD to replace these chemicals when possible and identify compliant processes and/or equipment when it is not. Project TRIAD follows the

replacement process through research and identification, testing and validation, development of implementation plans and technical order (TO) changes, and shop implementation and training.

TECHNICAL APPROACH

Each of the target process areas were addressed in three stages, according to the TRIAD management methodology: 1) Process Evaluation and Alternative Identification, 2) Alternative Testing and Verification, and 3) Alternative Process Implementation.

Hand-Wipe Cleaning

Hand-wipe processes at Robins AFB include pre-paint wipedowns, pre-adhesive cleaning, spot cleaning, and plastic media blast (PMB) residue removal prior to painting. Hand-wipe cleaning processes must meet the requirements of Aerospace NESHAP regulations by 1) using either an aqueous or hydrocarbon-based solvent, 2) using a solvent having a composite vapor pressure of 45 mm HG or less at 20(C, or 3) demonstrating that the volume of hand-wipe solvents used in cleaning operations has been reduced by at least 60 percent from a baseline adjusted for production. These regulations are per 40 CFR 63.744 (b). Though some of the above listed processes are exempt under the Aerospace NESHAP, Robins AFB has targeted them under their hazardous air pollutant (HAP) and toxic release inventory (TRI) reduction programs.

Process Evaluation and Alternative Identification. The first step in developing alternative materials and/or processes is thoroughly evaluating the current operation to determine the process requirements. Hand-wipe processes were evaluated in the C-130, C-141, C-5, and F-15 aircraft directorates and the TI industrial support directorate. Table 1 provides a list of the processes evaluated during the course of this effort.

Table 1

Hand-Wipe Cleaning Processes

Directorate Buildings Solvents Currently in Use Hazardous Constituents Classifications LB 44, 91, Pad 9 Marsol,
MIL-C-38736B, Type I Toluene
Xylene
Ethyl Benzene HAP, TRI
HAP, TRI
HAP, TRI LB 44, 91, Pad 9 Denatured Alcohol Methanol
Toluene HAP, TRI
HAP, TRI LB 50 MEK MEK HAP, TRI LC 54 MEK MEK HAP, TRI LC 125 Marsol,
MIL-C-38736B, Type I Toluene
Xylene
Ethyl Benzene HAP, TRI
HAP, TRI
HAP, TRI LC 125 Denatured Alcohol Methanol
Toluene HAP, TRI
HAP, TRI LF 137B MEK MEK HAP, TRI LJ 47, 81, 82 Marsol,
MIL-C-38736B, Type I Toluene
Xylene
Ethyl Benzene HAP, TRI
HAP, TRI
HAP, TRI LJ 47, 89 Isopropyl Alcohol None NA LJ 81, 82 Denatured Alcohol Methanol
Toluene HAP, TRI

HAP, TRI LJ 81, 82 Ethyl Alcohol None NA LJ 89 MEK MEK HAP, TRI LJ 89 Toluene Toluene HAP, TRI TI 125 Denatured Alcohol Methanol Toluene HAP, TRI
HAP, TRI TI 169, 180, 605, 670 MEK MEK HAP, TRI TI 169 Toluene Toluene HAP, TRI TI 169, 670 Isopropyl Alcohol None NA TI 180 Toluene Toluene HAP, TRI TI 605 Dry Cleaning Solvent Benzene HAP, TRI The process analysis focused on the solvents currently being used, the substrate upon which they were used, the contaminants removed from the substrates, and the paint systems applied to the substrates following hand-wipe cleaning. Common substrates included aluminum, magnesium, steel, titanium, and some composites. The contaminants being removed from the surfaces were typically jet fuel, hydraulic fluids, lubricating oils, PMB residue, and uncured adhesives and sealants. Based on the data gathered regarding the current operation, performance criteria were developed against which alternatives are tested. The performance criteria include regulatory requirements, chemical characteristics, material compatibility, and performance requirements which alternatives must meet for implementation. The performance criteria addresses specific testing that must be performed on each alternative as well as the standards that each must meet.
Based on the process evaluation and subsequent performance criteria, SAIC identified potential alternatives through literature searches, testing review, and networking. SAIC focused on Original Equipment Manufacturers (OEM) and Department of Defense (DoD) maintenance facilities as sources of initial information. These facilities perform operations similar to those at Robins AFB and are under the same requirements to implement alternatives to comply with the Aerospace NESHAP. Included in the investigation were Boeing (California, Washington, and Georgia plants), Lockheed-Martin (Texas and California operations), Northrop Grumman (California, Georgia, and Florida plants), Sacramento ALC, Oklahoma City ALC, and Ogden ALC. A thorough vendor and literature search followed the investigation to form the list shown in Table 2.
Table 2
Hand-Wipe Alternative Cleaners
Product Manufacturer Product Manufacturer Desoclean 110 Courtaulds Aerospace DS-104 Dynamold Solvents, Inc. DS-108 Dynamold Solvents, Inc. MPK Eastman Chemical Company LPS 104F LPS Laboratories, Inc. LPS Super 140 LPS Laboratories, Inc. Pensolv K4HP West Penetone Pensolv R-420 West Penetone PF Degreaser PT Technologies, Inc. Positron Ecolink, Inc. Prepsolv Ecolink, Inc. SD 1291 Brulin & Company, Inc. Skykleen 1000 Aviation Solvent Solutia, Inc. Skykleen 2000 Solutia, Inc. Teksolv EP Inland Technology, Inc. ALK-660 Eldorado Chemical Company, Inc. Armakleen M-AERO-NS Church & Dwight Co., Inc. B&B Re-Gel B&B Tritech, Inc. Calla 800 Zip-Chem Products Cee Bee A-882 McGean-Rohco, Inc. Cee Bee A-883 McGean-Rohco, Inc. DOT 111/113 Delta-Omerga Technologies, Ltd. Penair HD-2 West Penetone Penair HD-3 West Penetone Penair HD-4 West Penetone Qualchem 87932 Qualchem X-It PreKote PreKote Industries, Inc. Due to time constraints, it is not possible to test all of the above cleaners prior to the compliance deadline. Therefore, based on available chemical and testing data, SAIC recommended that methyl propyl ketone (MPK), LPS 104F, and Pensolv K4HP be further tested according to the performance specification and implemented in the maintenance facilities based on the results.
Spray Gun Cleaning

Following painting and some sealant applications, Robins AFB personnel are required to clean the spray guns and other equipment associated with the coating operation. The cleaning of spray guns and other coating application equipment are regulated according to NESHAP Title 40, Part 63, Subpart GG-National Emissions Standard for Aerospace Manufacturing and Rework Facilities, sections 63.744, 63.749, 63.751, and 63.752. All cleaning operations using HAP-based solvents must comply with these paragraphs. Spray gun cleaning operations in the C-130, C-141, C-5, and F-15 aircraft directorates have been targeted for replacement with compliant systems.

Process Evaluation and Alternative Identification. The TRIAD approach was modified slightly to address the spray gun cleaning operations in the aircraft directorates on Robins AFB. Due to the short time constraints and complexity of testing new solvents for cleaning coatings from the equipment, Robins AFB and SAIC agreed to focus on identifying, testing, and implementing compliant cleaning equipment in accordance with the above referenced regulations. Current spray gun cleaning operations were evaluated in the applicable directorates, investigating the equipment and solvents used in the processes. A baseline, including information on chemical characteristics, regulations, fire hazards, safety, exposure limits, and cost, was developed against which alternatives were compared. General performance requirements were also solicited from Robins AFB shop personnel to address preferred features on alternative equipment. Finally, SAIC addressed the NESHAP regulations as they apply to spray gun cleaning.

Based on the performance requirements and preferences reported in the baseline, SAIC identified several pieces of compliant equipment. The equipment is broken into three types: 1) integrated gun washer/solvent reclaimer systems, 2) gun washer units, and 3) solvent reclaimers. The vendors, models, and costs are presented in Table 3.

Table 3

Spray Gun Cleaning Equipment

Vendor Model Cost Integrated Gun Washer/Solvent Reclaimer Systems Becca 009701 Gun Washer/ Reclaimer $10,495.00 009700 Gun Washer/ Reclaimer $8,995.00 Doumar DGWRS3 Gun Washer/ Reclaimer $6,999.10 Omega GWRS-3AS-1-2 Gun Washer/ Reclaimer $5,999.00 Gun Washer Units Binks 40-3550 Gun washer $1,250.00 Graco 112-636 Gun Washer, Premium Model $1,535.97 112-635 Gun Washer, Standard Model $951.93 112-634 Gun Washer, Economy Model $615.04 Herkules GW/R-3-100-SS-T $1,995.00 GW/R-100-SS-T $1,895.00 Safety-Kleen2 1111- Combination Spray Gun & Equipment Cleaner (#077) †† Solvent Reclaimer Units Becca Beccaclean-7 Model 009725 $5,595.00 Beccaclean-5 Model 009711 $4,495.00 Binks 40-3500 Reclaimer $5,200.00 40-3545 Reclaimer $2,850.00 CB Mills MICRO 7.5 $7,500.00 Doumar DS12E Reclaimer $2,699.00 PBR Industries IRAC AV 30 XE $5,493.00 Based on quality and efficiency of design, ease of use, and compliance with both NESHAP regulations and Robins AFB requirements, SAIC has recommended that the Becca 009701 Gun Washer/Reclaimer system be purchased and prototyped. While it is the most expensive system, it offers capabilities others do not, including a reclaimer with an LED readout, computer diagnostic capability, and a 6 gallon capacity boiler (as compared to 3 gallon boilers on other units). While gun washer/reclaimers systems are appropriate for large use facilities, smaller operations can effectively use gun washer only units in their processes. All of the units evaluated had similar capabilities, but the Herkules GW/R-3-100-SS-T most closely matched Robins AFB personnel's

requirements. Both of these units are being purchased will be prototyped tested and evaluated for implementation.

Depaint

The depaint or paint stripping of F-15 wings and stabilizers is regulated by the Aerospace NESHAP. Currently, methylene chloride and phenol-based paint strippers are used to remove the coating systems from these parts. The depainting of parts not normally removed from aircraft is regulated under 40 CFR 63, Subpart GG, National Emissions Standards for Aerospace Manufacturing and Rework Facilities, section 63.746. Robins AFB has also targeted the depaint operations for replacement in accordance with their HAP and TRI reduction programs.

Process Evaluation and Alternative Identification. As a first step in identifying alternatives to the depaint processes, the current operation was thoroughly evaluated and a baseline developed against which to compare potential replacements. The baseline formed a benchmark and included information on the chemical characteristics of the current products, regulations, substrates and paint systems, fire, safety, and exposure hazards, and cost. Products currently being used in the TI industrial support directorate depaint facility are presented in Table 4.

Table 4

Current Depaint Products

Paint
Remover Primary Hazardous
Constituents Classification:
TRI or HAP B & B 1567C Methylene Chloride
Phenol Yes
Yes Yes
Yes Cee Bee A-236 Methylene Chloride
Methanol
Toluene Yes
Yes
Yes Yes
Yes
Yes Cee Bee A-458 Methylene Chloride Yes Yes Cee Bee R-256 Methylene Chloride
Phenol Yes
Yes Yes
Yes HT-2230 Ethylene Glycol Butyl Ether
Ethanolamine Yes
No Yes
No PR-3400 Methylene Chloride Yes Yes Analysis of the process focused on the chemical characteristics of the products currently being used for depainting, the paint systems being removed, and the substrates from which paint was being stripped. Common substrates include aluminum alloys, titanium, boron epoxy composite, and graphite epoxy composite. The paint system being removed from the F-15 wings and stabilizers is comprised of epoxy primer, MIL-P-23377, and polyurethane topcoat, MIL-C-85285. Based on the evaluation of the current process and review of applicable standards, SAIC developed performance criteria against which alternatives are compared. The criteria include applicable testing to determine stripping efficiency, material compatibility, rinsibility, flammability, and other chemical characteristics.

Following the information gathered during the process evaluation and development of the performance criteria, SAIC performed an extensive literature search to find applicable stripping materials. As with the hand-wipe process, potential alternatives were identified from existing testing and performance data as gathered by other ALCs and OEMs. The organizations contacted include Ogden, San Antonio, Oklahoma City, and Sacramento ALCs, Lockheed (Texas and Georgia operations), Boeing (California and Washington operations), and Northrop Grumman (California and Georgia operations). From these contacts and vendor searches, an extensive list of paint stripping products were researched and evaluated. After eliminating many of the products due to composition, pH, viscosity, and flammability, a short list of paint stripping products was designated for further evaluation and testing. This list is provided in Table 5.

Table 5
Potential Depaint Alternatives
Product Manufacturer Product Manufacturer B & B 5151B
Benzyl alcohol
Proprietary Ingredients B&B Tritech, Inc. PREP RITE
N-methyl Pyrrolidone
Triethanolamine Ecolink, Inc. B & B 9575
Benzyl alcohol
Ammonium hydroxide
Aromatic hydrocarbon
Proprietary Ingredients B&B Tritech, Inc. SR-145
Ammonia
Benzyl alcohol
Proprietary Ingredients Eldorado Chemical Company PR-3170
Ammonia
Proprietary Ingredients Eldorado Chemical Company Turco 6813-E
Benzyl alcohol
Linear alkylated aryl hydrocarbon
Ammonium hydroxide
Anisole
Water Turco Products, Inc. PR-5000
Unknown peroxides
Proprietary Ingredients Eldorado Chemical Company Turco 6840-S
Benzyl alcohol
Linear alkylated aryl hydrocarbon
Ammonium bicarbonate
Water
Surfactant Turco Products, Inc. PR-5555 (PR-3170/PR-5000)
Ammonia
Unknown peroxides
Proprietary Ingredients Eldorado Chemical Company Turco 6867
Benzyl alcohol
Linear alkylated aryl hydrocarbon
Boric Acid/ Diethanolamine
Ammonium hydroxide

Proprietary Ingredients
Water Turco Product, Inc. Based on SAIC's evaluation, all of the above listed products are recommended for further testing in accordance with the performance criteria. Due to short time constraints, the list of products to be tested may be reduced to facilitate compliance with the 1 September 1998 implementation date.

CONCLUSION

Project TRIAD is the most comprehensive effort ever launched to provide regulatory compliance through pollution prevention initiatives on Robins AFB. Instead of stop-gap measures and control technologies, the Robins AFB-SAIC partnership is eliminating the compliance burden and liability at the source. TRIAD successfully interweaves the requirements of the ESOH community and systems engineers, providing a flexible methodology to attack compliance issues and hazardous material usage. Project TRIAD is producing the necessary performance specifications, testing protocols, and implementation plans to bring about process changes and eliminate the compliance issues. A three-way parnership-systems engineers, the ESOH community, and SAIC-developed through Project TRIAD, continues to meet the needs of Robins AFB.

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